

Trimmatothelopsis ireneana* & *T. wendyana* spp. nov. from South Korea, with a key to *Trimmatothelopsis

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ABSTRACT—*Trimmatothelopsis ireneana* and *T. wendyana* are described as new species based on collections from South Korea. *Trimmatothelopsis ireneana* is characterized by dark brown, punctiform apothecia having a raised dark brown apex, by the 0.1–0.3 mm wide, yellowish thallus areoles, and by a low (130–175 µm) hymenium. *Trimmatothelopsis wendyana* is characterized by reddish punctiform apothecia, by the smooth, yellowish brown, thallus areoles with round to irregular shape, overlapping as if a squamulose thallus, and by a high hymenium (220–250 µm). A phylogenetic analysis demonstrated the two species to be closely related and separated from other *Trimmatothelopsis* species as new clades in the mtSSU analysis. In the ITS analysis, the clade of the two new species was found to be a sister to *T. rhizobola*. A key is presented to all 13 accepted species of *Trimmatothelopsis*.

KEY WORDS—*Acarosporaceae*, taxonomy, *Acarospora*, lichens

Introduction

The lichen genus *Trimmatothelopsis* Zschacke belongs to the lichen family *Acarosporaceae*. It is morphologically similar to *Verrucaria* Scop., but it differs with multi-spored asci and persistent interascal filaments (Ertz & Diederich 2004). However the ascomata are apothecia with paraphyses rather than perithecia with paraphysoids (Gueidan & al. 2014, Knudsen & Lendemer 2016). Thirteen species have been described in the genus *Trimmatothelopsis*. They are distributed worldwide, and occur on rocks and soil (Gueidan & al. 2014, Knudsen & Lendemer 2016, Knudsen & al. 2011, Kondratyuk &

al. 2015, McCarthy 2008, Navarro-Rosinés & al. 1999, Roux & Navarro-Rosinés 2002). The largest number of species was recognized by Knudsen & Lendemer (2016), who transferred *Acarospora dispersa*, *A. rhizobola*, and *A. terricola*; *Melanophloea americana*, *M. coreana*, and *M. montana*; and *Thelocarpella gordensis* into *Trimmatothelopsis*, based on mitochondrial small subunit rDNA (mtSSU) analysis (Knudsen & al. 2016). In their molecular study, *Trimmatothelopsis* formed a strongly supported monophyletic clade that was sister to the clade with *Acarospora*, *Polysporina*, and *Sarcogyne*. An additional, three *Acarospora* species (*A. oreophila*, *A. sphaerosperma*, and *A. benedarensis*) have been transferred to *Trimmatothelopsis* based on molecular and micromorphological analyses (Knudsen & al. 2021).

The presence of *Trimmatothelopsis* in Korea has previously been overlooked. Using a molecular phylogenetic analysis, 54 of 124 *Acarospora* or *Endocarpon* samples appeared to belong to *Trimmatothelopsis*, including two unknown clades which are presented here as new species. These samples were identified preliminarily as *Acarospora* and *Endocarpon* spp. following traditional, morphology-based taxonomy, since they had apothecial ascomata similar to perithecial ascomata and brown thallus areoles. Seventeen species of *Acarosporaceae* (*Acarospora fuscata*, *A. hospitans*, *A. insolata*, *A. nitrophila*, *A. privigna*, *A. smaragdula*, *A. ulleungdoensis*, *A. veronensis*, *A. versicolor*, *Caeruleum heppii*, *Myriospora rufescens*, *Polysporina golubkovae*, *P. simplex*, *Sarcogyne clavus*, *S. regularis*, *S. ulleungdoensis*, and *Melanophloea coreana* [$\equiv$ *Trimmatothelopsis coreana*]) have been reported in South Korea (Aptroot & Moon 2014, 2015; Joshi & al. 2011; Kim 1981; Knudsen & Lendemer 2016; Kondratyuk & al. 2013, 2015, 2016a,b, 2017, 2018; Zhang & al. 2012). Here we provide characteristics of the new species, detailed morphological descriptions, and an identification key to all accepted species of the genus *Trimmatothelopsis* worldwide.

Materials & methods

Morphological study

All vouchers used in this study are deposited in the Herbarium, Korea National Arboretum, Pocheon-si, South Korea (KH) and the Herbarium, Korean Lichen Research Institute, Suncheon National University, Suncheon-si, South Korea (KoLRI). Morphological observations were made using a dissecting microscope (Olympus SZX7, Tokyo, Japan). The micromorphology of the ascomata was observed using a compound microscope (Olympus CX22LED, Tokyo, Japan). Cross-sections were cut by hand using razor blades and mounted in water. Color reactions on sections

of the hymenium were conducted using Lugol's iodine after pretreatment with 10% aqueous KOH solution (K/I). To identify the internal substances of each lichen, K (5% potassium hydroxide), C (aqueous solution of calcium hypochlorite), and P (paraphenylene diamine) solutions were used to examine the color reaction (chemical color tests; Orange & al. 2001). Chemical identification was performed by thin layer chromatography (TLC; Orange & al. 2001; Elix 2014)

DNA extraction and PCR amplification

Air-dried lichen thalli with ascomata were ground using a Mini-BeadBeater-16 (3450 rpm, 115 V, 10 A, BioSpec Products). DNA was extracted using a DNeasy Plant Mini Kit (QIAGEN, Valencia, CA, USA). PCR amplification was conducted using AmpliTaq DNA polymerase in corresponding buffer conditions. The following primers were used for PCR amplification: mtSSU1 and mtSSU3R for mtSSU (Zoller & al. 1999); and ITS1F (Gardes & Bruns 1993) and ITS4 and ITS5 (Zoller & al. 1999) for ITS. The PCR thermal cycling parameters were: initial denaturation at 95°C for 5 min, followed by 35 cycles of 95°C for 20 s, 55°C for 20 s, and 72°C for 30 s, and finally at 72°C for 3 min. The amplified DNA was concentrated and purified using a PCR quick-spin Product Purification Kit (iNtRON Biotechnology, Inc. Seongnam City, Korea), and then sent to Microgen Cooperation (Seoul, Korea) for sequencing.

Sequence alignments and phylogenetic analysis.

Specimens and sequences used in the phylogenetic analyses are listed in TABLE 1. Separate contigs were assembled and edited using SeqMan (Lasergene v. 7.1, DNASTAR). Sequence alignments were performed using ClustalW 1.83 (Thompson & al. 1994) We used *Trimmatothelopsis* sequences downloaded from GenBank and newly generated sequences: ITS sequences from 16 samples (*T. coreana* 8, *T. ireneana* 5, and *T. wendyana* 3) and mtSSU from 16 samples (*T. coreana* 7, *T. ireneana* 7, and *T. wendyana* 2). The outgroup sequences are the same as in previous publications (Knudsen & Lendemer 2016). Evolutionary analyses were conducted using MEGA X and MrBayes v. 3.2.6. Bayesian inference was performed on the data set using the Metropolis-coupled Markov chain Monte Carlo method (MCMCMC) in MrBayes v. 3.2.6 (Huelsenbeck & Ronquist 2001, Ronquist & Huelsenbeck 2003). Best fit substitution models were estimated using Akaike information as implemented in jModelTest v 2.15 (Darriba & al. 2012). The F81 model was selected for mtSSU and ITS. Each MCMCMC run was performed with four independent Markov chains and 10 million generations. Trees were generated 1000 times, and the first 25% were discarded. The remaining trees were used for calculating a majority-rule consensus tree with posterior probabilities (PP). We also conducted maximum likelihood (ML) analyses using MEGA X with bootstrap value (BP), and selected the GTR+G model. Phylogenetic trees were constructed using Figtree v. 1.4.4 (Rambaut 2012) with TreeView X v. 0.5.0.

TABLE 1. Specimens and sequences of *Trimmatothelopsis* and *Pycnora* used in the phylogenetic analyses.

SPECIES	LOCALITY & VOUCHER	ITS	mtSSU
<i>T. americana</i>	USA, Lendemer 35758 (NY 1664)	—	KX578716
	USA, Lendemer 35758 (NY 1663)	—	KX578715
<i>T. coreana</i>	South Korea, KH-L0007927	MT984219	—
	South Korea, KH-L0007953	—	MW001365
	South Korea, KH-L0007959	—	MW001366
	South Korea, KH-L0007960	—	MW001367
	South Korea, KH-L0007961	MT984217	—
	South Korea, KH-L0012318	MT984228	MW001368
	South Korea, KH-L0012319	MT984229	MW001369
	South Korea, KH-L0012321	—	MW001370
	South Korea, KH-L0012322	MT984230	—
	South Korea, KH-L0005899	MT984216	—
	South Korea, KH-L0007967	MT984215	—
	South Korea, KH-L0007931	MT984218	MW001364
<i>T. dispersa</i>	USA, Lendemer 44571	—	KX578714
<i>T. gordensis</i>	France, CR22826	KM879337	KM879331
	France, CR25858	KM879338	KM879332
<i>T. ireneana</i>	South Korea, KH-L0007356	MT984224	MW001355
	South Korea, KH-L0007359	MT984225	MW001356
	South Korea, KH-L0007386	—	MW001357
	South Korea, KH-L0007401	MT984227	—
	South Korea, KH-L0007403	—	MW001358
	South Korea, KH-L0007404	—	MW001359
	South Korea, KH-L0007410	MT984226	MW001360
	South Korea, KH-L0007422	MT984223	MW001361
<i>T. rhizobola</i>	Sweden, Westberg 2994	EU870640	EU870692

SPECIES	LOCALITY & VOUCHER	ITS	mtSSU
	Sweden, Westberg 3099	EU870641	EU870693
<i>T. terricola</i>	Czech, Knudsen 11216 & Sagar (S F256013)	LN810807	LN810932
	Czech, Knudsen 11216 & Sagar (S F256012)	LN810806	LN810931
<i>T. versipellis</i>	France, CR25921	KM879336	KM879327
	France, CR25922	KM879335	KM879328
<i>T. wendyana</i>	South Korea, KH-L0007787	MT984221	—
	South Korea, KH-L0002550	MT984222	—
	South Korea, KoLRI-010298	—	MW001362
	South Korea, KH-L0004196	MT984220	MW001363
<i>P. sorophora</i>	Sweden, Hermansson 7903a (UPS)	FJ959357	—
<i>P. xanthococca</i>	Sweden, Hermansson 11849 (UPS)	—	AY853339

Bold font indicates new sequences published in this study.

Results & discussion

The two phylogenetic analyses led to different tree topologies; the most likely trees from the ML analysis of ITS (FIG. 1) and mtSSU (FIG. 2) are presented here. The ITS region contained 568 bp, of which 366 bp were conserved and 200 were variable. The mtSSU region showed 684 bp, of which 595 bp were conserved and 89 were variable.

In the mtSSU tree, the Korean samples showed up in three separate clades, corresponding to *T. coreana* and two new species, here proposed as *T. ireneana* and *T. wendyana*. This is consistent with the results of previous studies that employed mtSSU (Gueidan & al. 2014, Knudsen & al. 2011, Westberg & al. 2015). Each species was highly supported in the phylogenetic tree. The new species *T. ireneana* and *T. wendyana* together form a clade with weak support (57/1). *T. coreana* formed a weak clade (57/1) with other European and American *Trimmatothelopsis* species. The ITS analysis (FIG. 1) showed a different relationship: the two new species formed a monophyletic clade with strong support values (98/1), and this clade together with *T. rhizobola* also had strong support (90/1). However, in the mtSSU analysis, the relationship between the two new species and *T. rhizobola* was not resolved, because of low support values. *Trimmatothelopsis coreana* formed a strongly supported

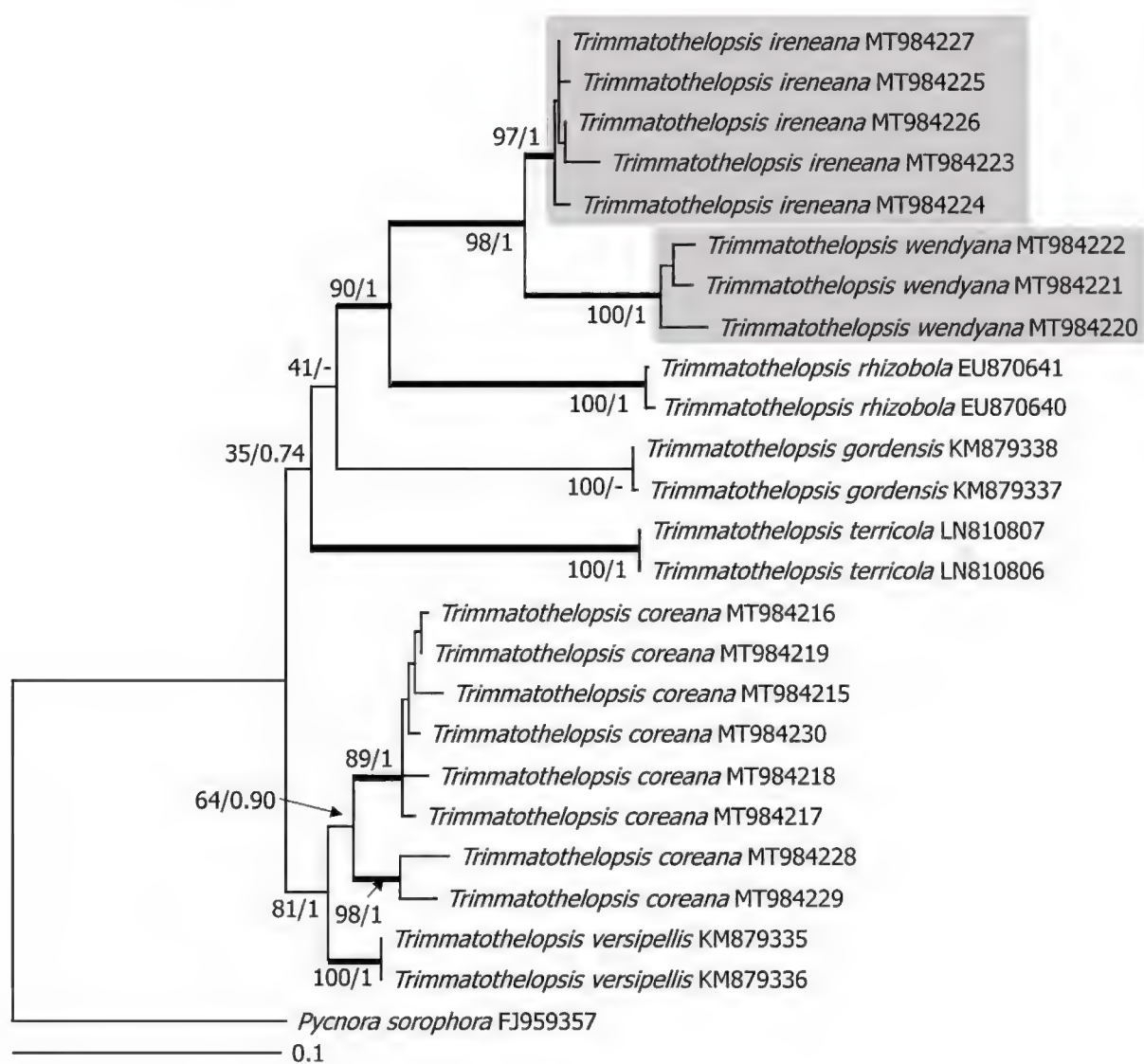


FIG. 1. Phylogenetic relationship in genus *Trimmatothelopsis*, based on Maximum Likelihood (ML) analysis of the internal transcribed spacer (ITS). Branches in bold indicate support of ML bootstrap $\geq 80\%$ and Bayesian posterior probabilities ≥ 0.90 . The clade shaded in grey corresponds with the two new species described in this study.

clade (94/1) and has a sister relationship with *T. americana*, *T. dispersa*, and *T. versipellis* (FIG. 2) with low support. Morphologically, the species is similar to *T. americana*; however, Knudsen & Lendemer (2016) examined the morphology of the *Trimmatothelopsis* species in order to identify morphological features that could serve as synapomorphies reflecting their shared evolutionary history. We applied their results to the two new species, and found that *T. ireneana* did not have pycnidia, unlike *T. dispersa* and *T. montana*, but has a high, globose hymenium with a disc size half or less of the equatorial diameter of the hymenium, and based on these morphological features this fits *Trimmatothelopsis*. *Trimmatothelopsis wendyana* also had a

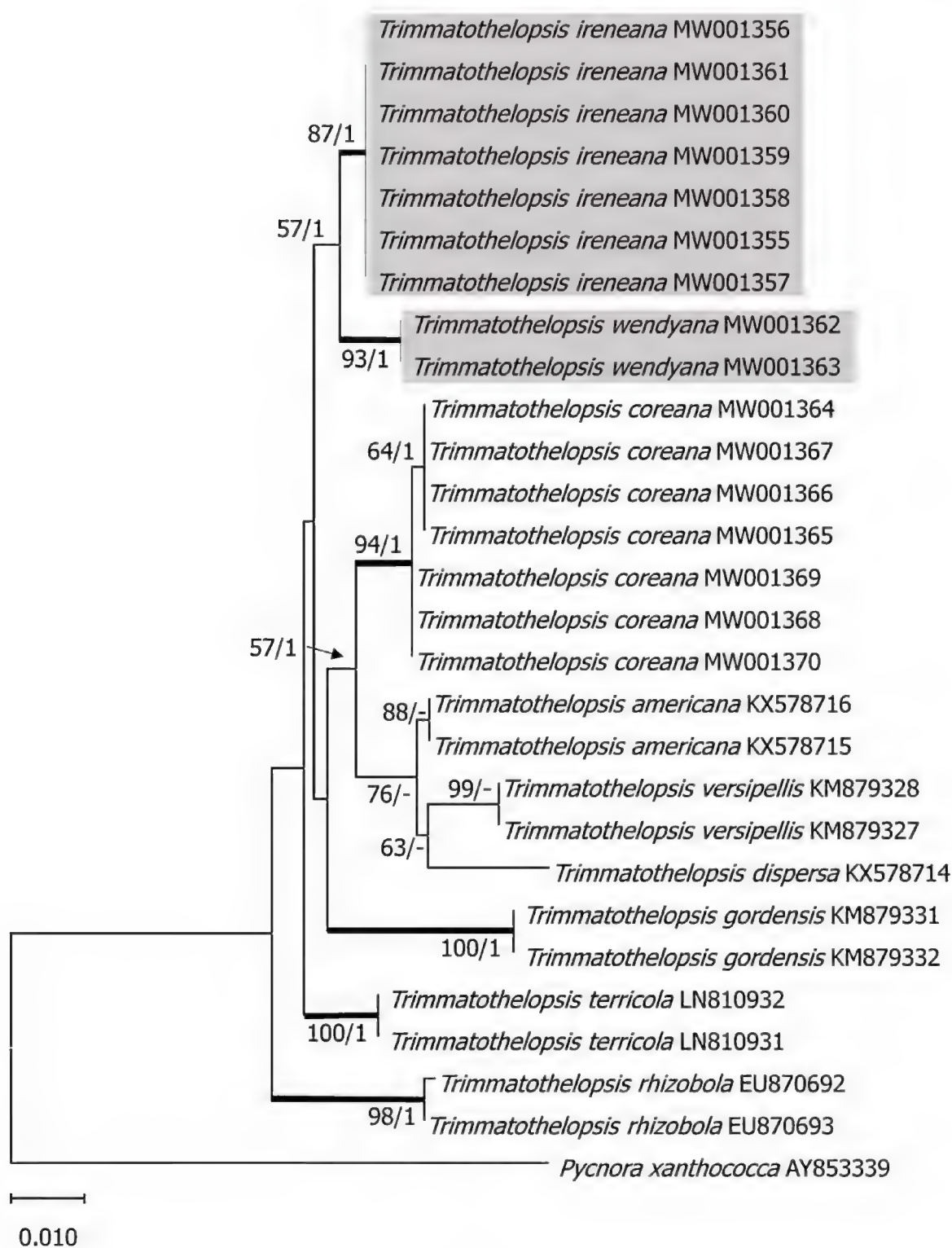


FIG. 2. Phylogenetic relationship in genus *Trimmatothelopsis*, based on Maximum Likelihood (ML) analysis of mitochondrial small-subunit (mtSSU). Branches in bold indicate support of ML bootstrap $\geq 80\%$ and Bayesian posterior probabilities ≥ 0.90 . The clade shaded in grey corresponds with the two new species described in this study.

high, globose hymenium, and long conidia (5–6 μm), and was equally included in *Trimmatothelopsis* because of morphological characteristics and molecular biological evidence. Most *Trimmatothelopsis* species have high hymenium (150–300 μm); but in four of the 11 recorded species it does not exceed 200 μm in height (*T. coreana*, *T. dispersa*, *T. terricola*, *T. versipellis*). *Trimmatothelopsis oreophila* has a high hymenium (170–220 μm) but a red-brownish thallus and thin areole size (0.1 mm vs. 0.5–1.5 mm). Further studies using additional genetic loci are required to confirm the significance of morphological features for recognizing the relationships between the species.

Taxonomy

Trimmatothelopsis ireneana J.S. Park & J. P. Halda, **sp. nov.**

FIG. 3

MB 837954

Differs from *Trimmatothelopsis coreana* by its distinct, round to irregular thallus areoles, its small punctiform apothecia, its globose, low hymenium, and the absence of pycnidia.

TYPE: South Korea, Jeju-do province, Seogwipo-si, Mt Halla, Yeongsil Trail, 33.3558°N 126.5003°E, alt. 1388 m, siliceous rock, 21 July 2015, J. Halda, K151652 (**Holotype**, KH-L0007404); K151605 (**Isotype**, KH-L0007395); K151651 (**Isotype**, KH-L0007403); K151653 (**Isotype**, KH-L0007405).

ETYMOLOGY: The species refers to Jeju-do, which is considered in Korea to be an island of peace. In Greek mythology, Irene is the name of the goddess of peace.

THALLUS areolate, areoles distinct, dispersed or somewhat contiguous replicating by division, usually single and widely dispersed, 0.2–0.3(–0.8) mm wide, mostly plane, tightly attached. UPPER surface yellowish brown to medium brown, epruinose. EPICORTEX absent. EUCORTEX with upper layer yellowish brown to dark brown and approximately 10 μm thick, paraplectenchymatous, and with a lower layer of hyaline, hyphal bundles penetrating the algal layer and 20–25 μm thick. ALGAL LAYER mixed with the lower cortex layer, 87.5–125 μm thick, uneven, and jagged in most areoles. MEDULLA white, prosoplectenchymatous, continuous, with attaching hyphae connected to the substrate, up to 150–180 μm thick, hyphae thin-walled and mostly 1 μm in diameter. APOTHECIA punctiform, diameter 0.1–0.3 mm, slightly concave in the middle of the discs, some of the apothecia having a raised dark brown apex, epruinose, mostly one per areole, and immersed in thalline warts, disc not carbonized; PARATHECIUM paraplectenchymatous, hyaline, 12–15 μm thick; EPIHYMENIUM medium brown to blackish brown, color dissolving in KOH; HYMENIUM globose, hyaline, K/I–, 130–175 μm tall; SUBHYMENIUM up to 20 μm thick, hyaline with oil droplets; PARAPHYSES 1–2.5 μm at mid-level, not

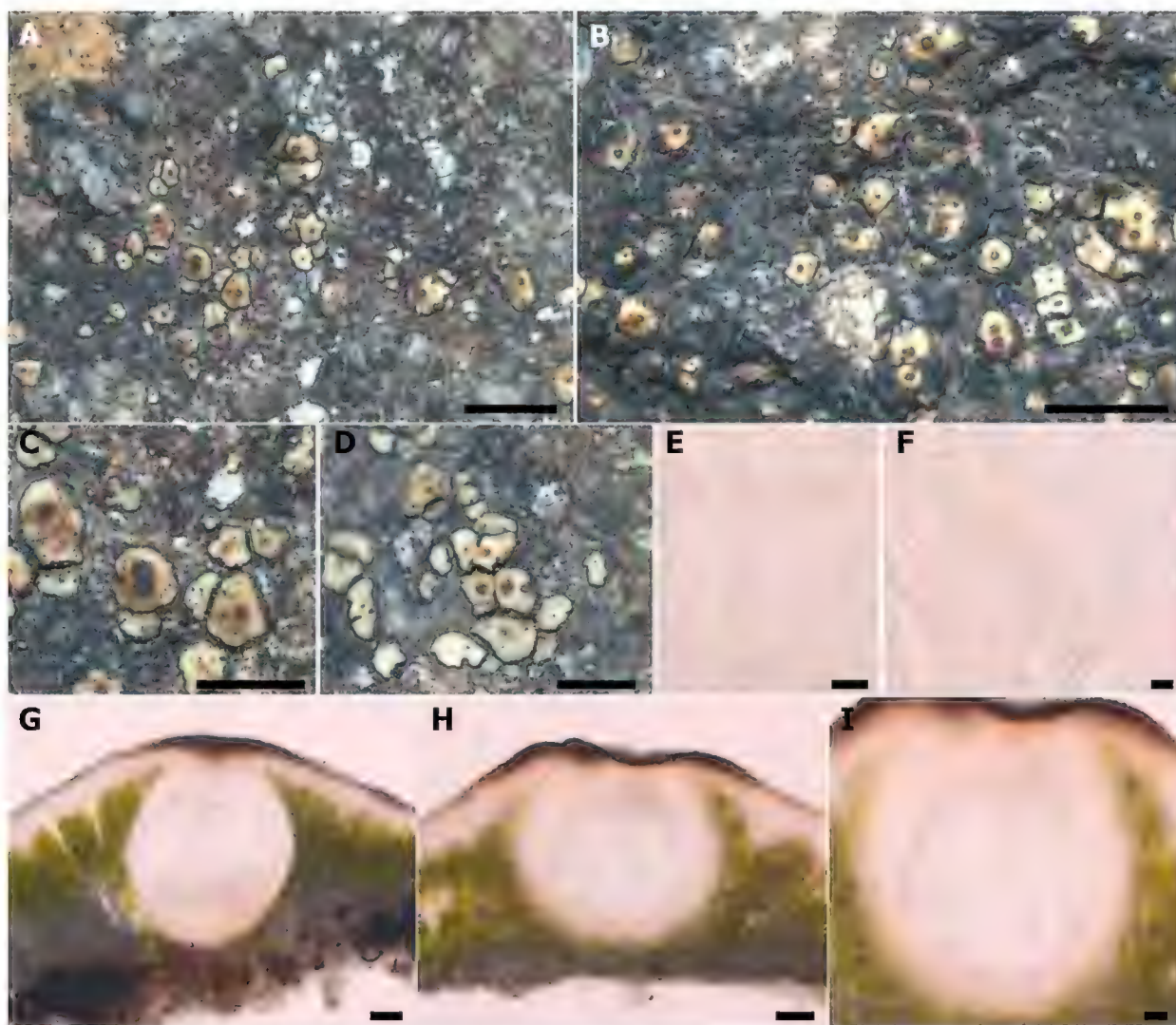


FIG. 3. *Trimmatothelopsis ireneana* (A–D = holotype, KH-L0007404; E–H = isotype, KH-L0007403; I = KH-L0007359): A. Thallus areoles with brownish punctiform apothecia; B. Continuous areoles with brownish punctiform apothecia; C. Close-up of apothecia having raised dark brown apex; D. Close-up of brownish punctiform apothecia; E. Paraphyses; F. Ascospores; G, H. Vertical section of an ascoma, uneven algal layer; I. Hymenium with ascus. Scale bars: A–D = 0.5 mm; E, F = 10 μ m; G, H = 50 μ m; I = 20 μ m.

swollen at the apices. ASCI narrowly ellipsoid, with K/I–, I– tholus, 130–135 $\times$ 20–30 μ m, polysporous, containing up to 200–300 spores. ASCOSPORES hyaline, simple, cylindrical, mostly 5 $\times$ (1–)1.5 μ m. PYCNIDIA not observed.

CHEMISTRY—No secondary metabolites detected.

DISTRIBUTION AND ECOLOGY—Collected only on Mt Halla on Jeju Island, where it grows on siliceous rocks at high altitudes in the mountain region. Known only from the type locality.

REMARKS—This species is characterized by brownish punctiform apothecia, 0.1–0.3 μ m wide, yellowish areoles, and a low (up to 175 μ m in height) hymenium. Four species of *Trimmatothelopsis* share a negative iodine reaction in the hymenium: *T. coreana*, *T. dispersa*, *T. terricola*, and *T. wendyana*.

Trimmatothelopsis terricola differs from *T. ireneana*, because it grows on biological soil crusts and has hyphal bundles, while in growing on rocks and lacks hyphal bundles. *Trimmatothelopsis ireneana* is similar to *T. coreana* in the punctiform apothecia with a parathecial ring, but differs by its smooth, brown apothecia that are smaller (0.1–0.3 mm vs. 0.3–0.5 mm), and its distinct brownish thallus. The new species is also similar to *T. dispersa*, which differs in its K/I+ blue reaction, whereas *T. ireneana* has a negative K/I color reaction. *T. ireneana* differs from *T. wendyana* in apothecia morphology; *T. wendyana* is distinguished by a red-colored punctiform disc and high hymenium (220–250 µm vs. 130–175 µm).

***Trimmatothelopsis wendyana* J.S. Park & S.O. Oh, sp. nov.**

FIG. 4

MB 843928

Differs from *Trimmatothelopsis dispersa* by its distinct round and squamuloid thallus areoles, its taller hymenium, and its pycnidia with bacilliform conidia.

TYPE: South Korea, Gangwon-do province, Yanyang-gun, Seo-Myeon, Peak of Galjeongokbng, 37.8691°N 128.4357°E, alt. 1101 m, siliceous rock, 22 May 2009, Y. Joshi & W.Y. Wang 090630 (**Holotype**, KoLRI-010298); Y. Joshi & W.Y. Wang 090638 (**Isotype**, KoLRI-010305).

ETYMOLOGY: This species is named in honor of Wendy, the favorite singer of the first author of this paper. Wendy had a serious accident that was very difficult to recover from, but after years of hard work she returned to the stage and is singing again.

THALLUS areoles distinct, dispersed, widely spaced or contiguous, sometimes extensive and often forming a dense crust, areoles more or less squamule-like, solitary to overlapping, round to irregularly shaped with an entire margin, 0.3–1.2(–1.5) mm in diam., mostly plane but some of the areoles convex, rim ± down-turned, often with a distinct black margin. UPPER SURFACE dull, yellowish brown, epruinose. EPICORTEX thin or absent. EUCORTEX with upper layer yellowish brown to pale brown, 8–10 µm thick, paraplectenchymatous, lower layer hyaline, of hyphal bundles, 37.5–62.5 µm thick. ALGAL LAYER including the lower cortex layer 45–100 µm thick, uneven, interrupted by hyphal bundles. MEDULLA hyaline, prosoplectenchymatous, continuous, with attaching hyphae connected to substrate, 50–100 µm thick. APOTHECIA punctiform, diameter 0.1–0.3 mm, solitary or up to 1–2 per squamules; DISC usually reddish brown, immersed, smooth, epruinose, with reddish stain surrounding the disc on the upper surface, not carbonized; EPIHYMENIUM medium brown, the color dissolving in KOH, 20–25 µm thick; HYMENIUM globose, hyaline, K/I–, 220–250 µm tall; SUBHYMENIUM hyaline, up to 25–37.5 µm thick. PARAPHYSES 0.6–0.8 µm thick at mid-level, not swollen at the apices. ASCI narrowly ellipsoid,



FIG. 4. *Trimmatothelopsis wendyana* (holotype, KoLRI-010298) A. Thallus areoles with developed apothecia; B. Close-up of reddish punctiform apothecia and squamule-like overlapping areoles; C. Close-up of reddish, punctiform, immersed apothecia; D. Vertical section of apothecia and hymenium; E. Ascus and ascospores; F. Conidia. Scale bars: A–C = 0.5 mm; D = 40 μ m; E, F = 8 μ m.

with K/I–, I– tholus, 100–110 $\times$ 13–15 μ m, polysporous, containing up to 100–200 spores. ASCOSPORES hyaline, simple, cylindrical, 4.7–5.3 $\times$ 1.3–2.1 μ m. PYCNIDIA not numerous, resembling punctiform apothecia, 100–120 μ m wide, up to 175 μ m high, dacryoid to globose, conidia bacilliform, cylindrical, 5–6 $\times$ 1 μ m.

CHEMISTRY—No secondary metabolites detected.

DISTRIBUTION & ECOLOGY—It grows on siliceous rocks at mainly high altitudes in the mountain region.

ADDITIONAL SPECIMENS EXAMINED—SOUTH KOREA, GYEONGSANGBUK-DO, Mungyeong-si, Mungyeong-eup, Gjigok-ri, Mt Juheul, 36.7750°N 128.1081°E, alt. 1070 m, on rock, 29 February 2004, J. S. Hur, 040146 (KoLRI-000913); Gyeongju-si, Geeoncheon-eup, Mt. Danseok, 35.8178°N 129.0839°E, alt. 185 m, on rock, 16 June 2016, S.-O. Oh, C.S. Kim, Y.N. Kwag, S.K. Han KL16-0257 (KH-L0007787).

REMARKS—This species has a reddish to brownish punctiform apothecia and is mistaken for a species of *Endocarpon*. It is similar to *T. dispersa*, which has a reddish brown disc, lower hymenium size, with pycnidia not being observed. In contrast, *T. wendyana* has a distinct red punctiform disc, high hymenium (220–250 µm vs. 150–200 µm) with pycnidia and 5–6 µm bacilliform conidia. *T. wendyana* is similar to *T. ireneana* and *T. coreana*, but the latter two species can be distinguished by their distinct thalli. *T. ireneana* and *T. coreana* have small size areoles (0.3–0.5 mm) and are not overlapping, while *T. wendyana* has larger, overlapping areoles (1.5–2 mm). Moreover, it has a high hymenium (220–250 µm vs. 130–190 µm in *T. ireneana* and *T. coreana*).

Key to *Trimmatothelopsis* species (updated from Knudsen & Lendemer 2016)

- 1. Thallus on soil (terricolous) 2
- 1. Thallus on rock (saxicolous) 4
- 2. Squamules peltate, deep red to dull brown; on peaty soil over mica schist
..... *T. rhizobola*
- 2. Squamules crust-forming, yellowish or reddish brown to black, on soil of
coastal cliffs in sunny exposures 3
- 3. Squamules angular to irregular, 1–3 mm wide, apothecia inconspicuous
when dry, 1–5 per areole *T. benedarensis*
- 3. Squamules round to irregular, up to 1.3 mm wide, apothecia often lacking,
usually one per areole *T. terricola*
- 4. Ascospores mostly 0.5–1.5 µm wide, eastern North America 5
- 4. Ascospores mostly 2–2.5 µm wide, eastern North America or elsewhere 6
- 5. Thallus indistinct, apothecia discoid, arising individually, superficial,
broadly attached *T. americana*
- 5. Thallus distinct, squamulose, apothecia punctiform, 0.1–0.2 µm wide,
often sterile *T. oreophila*
- 6. Thallus on calcareous rock 7
- 6. Thallus on non-calcareous rock 9
- 7. Ascospores spherical, over 5 µm wide *T. sphaerosperma*
- 7. Ascospores ellipsoid, not over 5 µm wide 8
- 8. Tholus at least faintly amyloid; known only from Europe (coastal France)
..... *T. gordensis*

8. Tholus non-amyloid; widespread in North America *T. dispersa*
9. Hymenium K/I+ blue 10
9. Hymenium K/I– 11
10. Thallus areolate, round to irregularly shaped; apothecia punctiform, solitary or up to six or eight in dividing areoles *T. dispersa*
10. Thallus not areolate, sparingly to richly rimose, smooth, apothecia resembling perithecia, convex to hemispherical, known only from Australia *T. montana*
11. Apothecial disc carbonized; known only from Europe (France) *T. versipellis*
11. Apothecial disc not carbonized; known from Asia or North America 12
12. Thallus indistinct; apothecial disc round, forming a conspicuous, dark brown to black apex on the apothecia, slightly raised, resembling perithecia *T. coreana*
12. Thallus distinct; apothecial disc punctiform, brown to reddish brown 13
13. Thallus continuous, with overlapping, squamule-like areoles, apothecia reddish; hymenium mostly over 220–250 µm high *T. wendyana*
13. Thallus dispersed, without overlapping squamule-like areoles; apothecia dark brown; hymenium 130–175 µm high *T. ireneana*

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